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DEATH DURING ANÆSTHESIA

BY

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THE candid discussion of the deaths resulting from any procedure in medicine is compassed about with many difficulties. At best it is painful to lose a patient and it is but natural to shrink from the recollection. For the same reason the "safety" of anæsthesia is a recurrent and fertile subject of argument. Unfortunately any discussion of safety has usually turned on the anæsthetic agent in use instead of on the skill and experience of the administrator of that agent, or on the condition of the patient. Patients vary from a state of perfect health to a condition of impending death; and anæsthetics are administered by persons of no skill or clinical training whatever as well as by men of the greatest learning and the highest competence.

Those who report results in print have often failed, in the past, to state their definition of "mortality." Surgeons are prone to refer to the "immediate" and "remote" mortality of operations without explaining what they mean by these terms. The laudable habit of keeping records accurately in writing is still so new among anæsthetists that to them "mortality" usually means the number of patients who died on the operating table. To some it means death before the recovery of consciousness from anæsthesia. To few does it mean the number of patients who died before their discharge from hospital.

It is unfortunate that in England the practice of Coroners' Courts was to require an inquest on patients who died in the operating room. I believe that the letter of the law was more strict and demanded that any death which occurred before the recovery of consciousness should be reported. The result, however, was that on many occasions a dying patient, whose only faint hope of survival lay in absolute quiet and warmth, has been hurriedly sewn up and returned to bed in the hope that all signs of life would not be extinct before he had passed through the door of the operating room. On one occasion, when to the bystanders it seemed obvious that the patient had been dead for some time, the anæsthetist stoutly maintained that he could feel a pulse at the wrist until after the body had been placed in bed. Then, conveniently enough, the "pulse" disappeared. Such a state of affairs is not conducive to honesty, nor does it contribute much to our knowledge.

The cause of truth has suffered infinite harm from the tendency, thinly veiled by a jesting manner, of the anæsthetist to attribute fatalities to the activities of the surgeon, and vice versa. "We should not dissemble nor cloke" our sins, but "confess them with an humble, lowly, penitent and obedient heart." The Book of Common Prayer goes on to say, most appositely: "yet ought we most chiefly so to do when we assemble and meet together.". . . . The object of an operation—and therefore of anæsthesia—is fulfilled if the patient can be discharged from hospital in a condition no worse than that in which he entered it. There are many disorders which cannot be cured, and often in these the death of the patient is a foregone conclusion. If, however, an operation can relieve his symptoms and render death less fearsome, it is probably justified. If anæsthesia can contribute to this it is rendering a valuable service. Surgeons and anæsthetists are, as it were, members of a team whose object is to win the match. One particular player may be instrumental in losing the match, but the entire team shares in the sensation of defeat. We are still, however, an undisciplined team for each tries to shift the blame to the other in private conversation. In print or in public addresses recrimination is inadmissible and therefore the agent usually becomes the

scapegoat. This is as stupid as for a golfer to blame the clubs or the ball. There will be no real advance until surgeon and anæsthetist are sufficiently, in St. Paul's excellent phrase, "members one of another" that each feels deeply for the other's troubles. As the principal members of the team they must learn to act jointly, not severally. Their first concern should be to determine how many patients have been operated upon, and of those how many did not survive to be discharged from hospital. Then they should consider what caused the death of the patient and discuss how, in similar circumstances, a repetition of the death can be avoided.

I propose to state dogmatically certain definitions, in the hope of being more exact in the course of this essay. The "gross mortality" of surgical interventions is the number of patients who did not survive to be discharged from hospital or to be operated upon again. It is sometimes referred to as the "case mortality" or "mortality to discharge." By "immediate mortality" the anæsthetist should mean the number of patients who died before recovering consciousness after anæsthesia. This is sometimes difficult to determine. If a patient was unconscious before operation we may reasonably assume that he should not be placed in the "immediate" category if unconsciousness receded to the pre-operative level before death. In every case in which consciousness is not regained the anæsthetic must be held to have contributed to the death unless the contrary can be shown.

It is obvious that the immediate mortality of operations depends mainly on the nature of the operation and the condition of the patient before it. The desperately ill or moribund patient is, fortunately, rarely encountered in the course of general practice. If he is, his treatment almost invariably takes place in a general hospital. For this reason deaths during anæsthesia and operation should be uncommon in the experience of the general practitioner. If we are to obtain a fair view of the frequency of this accident it is to the records of the large general hospitals that we must look. Specialised institutions will provide an unfair picture in one or other direction. Institutions devoted to genito-urinary or neurological surgery will have a higher incidence of "death on the

table" than ones which practise orthopædics or oto-laryngology only. Helen Lukis brings out this point well[1] by giving the details of a series of 5,138 administrations of anæsthesia. About half of these were for serious operations in a hospital: the other half were for minor operations performed in the course of general practice. Of 2,966 administrations in hospital, three were to patients who failed to recover from the operation. This means an "immediate" mortality of .101 per cent. It may be that a fourth case should be included: that of a patient who did not recover consciousness after the removal of a cerebellar tumour. On the other hand this patient may already have been in coma before the operation began. The author also records a series of 2,172 administrations in the course of a general practice. One patient died on the table from "status lymphaticus." In this series, then, the "immediate mortality" was .046 per cent; and this is less than half the figure for the major procedures undertaken in hospital.

It often happens that authors of letters to the medical journals will refer to certain cases in their own practice. Rarely, however, do they mention the total number of administrations in the course of which the deaths have occurred. For this reason their figures are of no value for statistical purposes. Such is the case with the interesting notes of Elam.[2]

A controversy about "complacency in anæsthesia" has recently been raging in the pages of the *British Medical Journal*. In its course the question of the safety of anæsthetics has arisen several times. Amazingly enough, some of the participants have not considered the above factors. It is evident that operations such as tonsillectomy and herniorrhaphy should carry a very low mortality in patients otherwise healthy. These figures cannot justly be compared with those for thyroidectomy or gastrectomy in subjects who are usually poor risks. The latter cases fall to the lot of the large general hospitals; the former to the general practitioner.

[1] Lukis, H., *Problems of Anæsthesia in General Practice*, p. 24. London, 1935.

[2] Elam, J., *British Medical Journal*, 1941, II, page 207.

Immediate Mortality

A " death on the table " is the bugbear of the anæsthetist. It need not necessarily be his fault. Many surgical causes may be responsible. Hæmorrhage, or a decrease in effective circulation resulting from trauma are the usual precipitating causes. If a sufficient number of operations are performed upon patients in poor condition, sooner or later one of the fatal accidents will occur during operation. It may be a coronary occlusion or a pulmonary embolism. In such a case it is impossible to state that it would not have occurred then had the patient been lying at rest in bed. There are cases on record in which, an operation having been postponed, the patient died of such a cause at the time for which the operation had been arranged. Had the operation been carried out either it or the anæsthetic would have been blamed for the death.

The serious accidents of anæsthesia are usually sudden and often fatal. Our knowledge and mechanical aptitude have reached a point at which the function of respiration, vital as it is, is under the control of a skilled anæsthetist. A few years ago cessation of voluntary respiration in an anæsthetised patient was a sign of grave import. Nowadays, in certain circumstances, it is viewed with equanimity, and a skilled anæsthetist often produces apnœa deliberately for certain purposes. In the broadest sense the modern anæsthetist has " taken control of respiration." The function of circulation, however, remains its own master. If the myocardium ceases to discharge its function or the peripheral vessels undergo an alteration in tonus we are as helpless as ever. We are taught by the pharmacologists that certain drugs have a beneficial and others a harmful effect on the circulatory system. Of the causes of anoxia, which is the ultimate cause of all death, we can control those which arise from the process of " external " respiration. When " internal " respiration or circulation fails, little can be done. At best we can only apply " supportive measures " in good time.

In the practice of a large institution it frequently happens that a patient is admitted moribund. Sometimes the patient has neglected his own symptoms; sometimes his medical attendant has failed to reach a diagnosis. When the condi-

tion is surgical it is sometimes the case that in operative intervention lies the patient's only hope of recovery—a faint one at best. The services of an anæsthetist are therefore requested. It is perhaps natural that surgeons and anæsthetists are both reluctant to deal with such a situation: the chance of recovery is remote and the probability of death during operation is great. Nevertheless, if operation holds out the only reasonable hope of recovery and we are afraid to undertake it, we are guilty of professional cowardice and we are putting our professional pride before the welfare of the patient. If the anæsthetist thinks that the patient may die during the operation, it is his duty to make that prognosis known to the surgeon. If, in spite of this, the surgeon still feels that the case is hopeless without operation, we are not justified in trying to avoid anæsthetising that patient. The anæsthetist will, however, be wise to have a word with the patient's relatives. He will explain to them his opinion of the gravity of the case and the necessity for operation. By the exercise of a little tact it is possible to be considerate of their feelings and yet leave them in no doubt that death may occur during the operation. Such an interview is a strain which we all try to avoid, but to do so is unwise. If, after it, the patient does die the relatives are prepared and the news is not such a shock because they were aware of the possibility. If, on the other hand, the patient survives the operation, they feel relieved and pleased. Honesty is invariably the best policy.

Fifty years ago it was not unusual for the anæsthetist suddenly to ask the surgeon to "stop the operation." This may have been a reasonable request in days when both anæsthesia and major surgery were in their infancy, and the operations themselves savoured of the technique of a "snatch and grab" raid. Colour, pulse, and respiration apart, the anæsthetist had few means at his disposal of reaching a sound judgment of the patient's condition at the time, or his ability to withstand the next onslaught of the surgeon. The more carefully planned operations of to-day do not admit of a request that they be suddenly abandoned. It is futile to ask a surgeon to close the abdomen when he has undertaken a gastrectomy and the pylorus has just been divided!

It is, however, possible for him to wait for some minutes before pursuing a traumatic phase of an operation, and anæsthetists know the astonishing extent to which a patient, whose condition has been giving rise to anxiety, may recover if the trauma is arrested for a few minutes.

When we have the assistance of a chart which shows the variations in the patient's blood-pressure and pulse-rate we have no excuse for being taken unaware as to his condition. Should a sudden accident occur, we must be in a position to treat it effectively. As a rule this demands, not the cessation of the operation, but its completion in as short a time and with as little trauma as is consistent with mechanical efficiency.

On innumerable occasions a moribund patient has been successfully operated upon. He has recovered from the anæsthetic. In some rare cases he has even made a complete recovery. More often he dies, shortly after the operation, of the condition from which he is suffering. The experience of many such cases has brought me to believe that no patient is "too ill" either to be operated upon, or to be anæsthetised for the purpose—provided the anæsthetist is competent. It is, of course, true that a patient in extremis requires very little anæsthetic; and if he is in coma no anæsthesia is necessary as a rule. The ability to "temper the wind to the shorn lamb" is an important attribute of the skilled anæsthetist, for desperately ill patients cannot stand a relative overdose of an anæsthetic agent. If a patient is so near death that he "cannot" be anæsthetised, then he is too ill to stand a surgical incision. If he can, then he is well enough to tolerate a properly administered anæsthetic for the purpose. For this reason it seems doubtful whether, since he is never "in charge of the case," an anæsthetist is morally entitled to refuse his services in these circumstances. If he fulfils his professional duty and anæsthetises patients who are moribund, deaths during anæsthesia are, sooner or later, inevitable. The greater his skill and experience, however, the more proficient will he be in the gentle art of "tempering the wind. . . ." and the less often will a death during the operation be his lot.

We are concerned, then, to ascertain how many patients

may be expected to die during anæsthesia. It is only fair that we shall consider large numbers of cases in which operations of all manner of severity have been performed upon patients in different states of general health. This can only be determined by an examination of the records of large institutions. Table I shows the figures for five teaching hospitals on three different continents. Three of these results have appeared in print;[1] the remaining two are the fruit of examination of records to which I have had access.

TABLE I.

Source	Total cases	Deaths during anæsthesia	Per cent
Hospital A (10 years, 1932–42 inclusive)	44,894	47	0.104
Hospital B (8 years, 1930–38)	61,400	55	0.089
Hospital C (10 years)	51,392	75	0.15
Hospital D (10 years, 1923–27 and 1933–37)	25,692	51	0.198
Hospital E (15 years, 1919–34) ...	31,157	48	0.15
Author (10 years, 1932–42)	13,011	7	0.053
Total	227,546	283	0.12

It seems reasonable to suppose that conclusions may be drawn from as many cases as these. Almost a quarter of a million cases are considered, and of these two hundred and eighty-three did not recover from the operation and anæsthetic. The mean mortality during operation was therefore .12 per cent: just over one case in every thousand. Of the five institutions whose records are under consideration, one shows a mean mortality during operation almost identical with that of the entire series. In it, anæsthesia is administered by medical men only, although residents, interns, and medical students are constantly being clinically instructed, and the majority of administrations are by residents in the course of training.

In "Hospital B," whose mortality during operation is below the average, anæsthesia for major operations is ad-

[1] For "Hospital C" see: Lyford, J.; Berger, O. L.; and Shumacker, H. B. *Bulletin Johns Hopkins*, 1942, LXX, page 488. For "Hospital D" see: Edwards, G. *British Journal of Anæsthesia*, 1938, XV, page 87. For "Hospital E" see Kaye, G. *British Journal of Anæsthesia*, 1936, XII, page 110.

ministered by members of a fairly large visiting staff of consultants, who also teach the medical students. Dangerous emergency cases are treated by one of two resident anæsthetists. The easy cases, whether deliberate or emergency, fall to the lot of the interns. From the results it would seem that this system of allowing the less seasoned men to acquire their experience with the easier cases is a wise one.

In " Hospital C" all general anæsthetics are administered by nurse-technicians, and regional analgesia is the province of a member of the operating team. In " Hospitals D and E " it would seem, from the comments of the authors of the articles from which these figures were taken, that a desperately ill patient is often anæsthetised by a comparatively inexperienced anæsthetist. Two conclusions seem justifiable: (1) That if cases of all types in patients of all sorts and conditions are undertaken, death before recovery is likely to befall about one patient in every thousand. (2) That the allocation of beginners to easy cases, the more experienced anæthetists being expected to deal with the graver cases and with the instruction of younger men, serves to reduce the incidence of fatalities.

It is said that " confession is good for the soul," and therefore it is fitting that, after ten years of the administration of anæsthetics, I should recall the cases in which death has attended my efforts. During this decade I have administered, or supervised the administration of, 13,011 anæsthetics. This figure includes all administrations by medical students under my supervision in the course of seven years of teaching; but it does not include the occasions on which I have supervised or assisted an intern, resident, or any graduate medical practitioner. Seven of these patients have not survived the operation.

Case Reports

Case 1. July 1932

Oesophagectomy had previously been performed in a man of about 56. The growth had recurred and had caused ulceration in the neck. The patient was extremely cachectic and had determined to commit suicide unless something was done for his relief. To enable a laryngologist to attempt a tedious and extensive excision of the ulcerating

recurrence, the patient was anæsthetised with C_2E_3 mixture and ether by the open technique. Maintenance was by pharyngeal insufflation of ether and oxygen. The operation lasted for nearly two hours, and the patient, who was perspiring freely and had become more and more pale, died during it. The passage of time has obliterated exact detail from the memory, but the following facts remain. At that time an inexperienced House Surgeon, it seems probable that I maintained too great a depth of anæsthesia and failed to notice the signs which would have warned me of an impending tragedy. It is doubtful whether the pulse was carefully palpated: it was certainly not systematically counted and recorded. Unfortunately no autopsy was held.

Case 2. March 1933

An operation was undertaken for the removal of a cerebellar tumour in an otherwise healthy man of 43. Induction was with ACE mixture on an open mask. Nasal intubation was then performed by direct vision. Some epistaxis occurred, but the intubation was successful. Maintenance was with nitrous oxide and minimal ether by the semi-closed technique. The operation had been in progress for an hour and twenty-five minutes, and a chart of the blood-pressure and pulse-rate had shown no variations of note save a tachycardia during induction of 180—this, however, in a patient whose preliminary medication had consisted of gr. 1/75 of Atropine. The rate had, in the course of the operation, subsided to 120. A reading, taken at 1.10 p.m., showed pressures of 140/76 and a pulse-rate of 120. At 1-13 p.m. the patient suddenly ceased to breathe as the surgeon, who was about to open the dura, was applying the endothermy in its vicinity. There were no signs of life thereafter and it is probable that circulation failed at the same time as respiration. When withdrawn from the body the endotracheal tube was found to be partially occluded by a clot of blood which occupied about half its lumen. The post-mortem examination added nothing to our knowledge. The findings were not consistent with death from asphyxia, and the patient had a chronic basal meningitis and not a cerebellar tumour.

Case 3, January 1934

A very large and vascular meningioma was removed from the left frontal region of a woman sixty years of age. Anæsthesia was with nitrous oxide-oxygen-ether by the semiclosed technique, blind nasal intubation having been performed. The surgeon knew that the tumour was extremely vascular and made use of the upright position of the patient to diminish bleeding. Nevertheless profuse hæmorrhage took place and a donor of blood was summoned. He, however, did not arrive

for two hours because of some misunderstanding of a telephone message. By that time the blood-pressure had been 50/40 for ninety minutes and the pulse-rate, having risen to 140, was falling rapidly and was becoming more and more irregular. The transfusion was given but the patient died during its administration.

CASE 4. MAY 1934

A child of five was to have an appendicectomy. The appendix was perforated and general peritonitis had set in, but the child was not as yet desperately ill. It was midnight, and I had just finished anæsthetising another patient, being then senior resident. Since neither the surgeon nor I considered this child very ill, it was the function of one of the house staff to anæsthetise her. He, however, was detained by another case, and, to avoid a waste of time, I performed the induction with an open ethyl chloride-ether sequence. This was uneventful, and the " full duty anæsthetist " arrived as the patient was being taken into the operating room. I described to him what had been done and entrusted the patient to him. The child was apparently in good condition and anæsthesia was of the first plane of the third stage. Apparently the operation proceeded normally; the appendix was removed and the peritoneal cavity was drained. Anæsthesia was by then fairly deep: probably of the third plane. A pharyngeal airway was in place, but no oxygen was being administered. The child's ears were slightly grey. Abruptly, as the surgeon picked up the peritoneum to sew it, respiration and circulation both ceased. The autopsy provided no explanation of the death.

CASE 5. FEBRUARY 1935 [1]

A man of 55 was anæsthetised with nitrous oxide-oxygen chloroform by the semiclosed technique for the drainage of an abscess in the lower lobe of the right lung. Blind nasotracheal intubation was performed. The surgeon removed a rib over the site of the abscess, and, inserting a finger, he probed violently into the pulmonary tissue in search of the abscess. Suddenly the patient developed gross cyanosis, his pupils dilated widely, his respirations ceased, and pus began to drip from the expiratory valve to the floor. The table was hastily placed in the " Trendelenburg " position, the endotracheal tube was withdrawn, and a bronchoscope was used to aspirate a large quantity of foul pus. The patient, however, was already dead: drowned by the large volume of pus released when the surgeon's manipulations ruptured the abscess. Chloroform was used in this case because the surgeon intended to use the endothermy. No autopsy was performed.

[1] This case has already been described: Gillespie, N. A. *Endotracheal Anæsthesia*. Page 150. University of Wis. Pres. 1941.

Case 6. April 1937

In this case death occurred before recovery from anæsthesia, though not in the operating room. The patient was a very large, heavy man of twenty-four, on whose right ankle arthrodesis was to be performed. His weight was well over two hundred pounds, but physical examination had revealed no abnormality, and the local condition was not tuberculous. Preliminary medication had consisted of pantopon gr. 1/3 and scopolamine gr. 1/150, and anæsthesia was accomplished with open ether after an induction with ACE mixture on an open mask. Anæsthesia was conducted by a medical student under the supervision of a member of the visiting staff of anæsthetists. The task of maintaining an unobstructed airway in a patient whose neck was almost as wide as it was long and whose mandible was extremely difficult to hold forward, proved too much for the student even after a pharyngeal airway had been inserted. The staff anæsthetist therefore performed blind intubation. Maintenance of anæsthesia was uneventful, though the anæsthesia was deeper than the nature of the operation warranted. When the surgeon began to close the wound, the anæsthetist told the student to stop the administration, and to remove the endotracheal tube and substitute a pharyngeal airway at the close of operation. The staff man then went out to supervise induction in the next patient by another student. Having returned to the ward, the patient developed periodic respiration of the " Cheyne-Stokes " type. Whether this was due to pharyngeal obstruction or to some central cause is not clear. On two occasions apnoea and cyanosis occurred but were successfully treated by the house and nursing staff. On the third occasion these methods failed, and when the anæsthetist was able to leave the operating room, some forty minutes later, he found the patient dead. At autopsy an unsuspected pericardial adhesion was found.

Case 7. September 1939

A man of 57 was to undergo the removal of what had been diagnosed as a hæmangioma of the scalp. Induction was by means of 199 mgm. of avertin per kilo of body-weight. The patient was then intubated orally with a cuffed tube through which maintenance was achieved with nitrous oxide and oxygen. The lesion proved to be a huge meningioma which had eroded through the skull, and when the operation had proceeded for thirty minutes gross hæmorrhage was encountered. Three transfusions of about five hundred cubic centimetres were given within seventy-five minutes and still the blood-pressure remained at 60/40 and the pulse-rate at 120, for blood was lost from the head more rapidly than it could enter the vein. At this critical moment it was found that the fourth donor, who had just arrived, was incompatible with the

patient. The anæsthetist was therefore faced with a dilemna. Either he could give physiological saline, which will provide a circulating medium even if it will transport little oxygen, or he could give nothing and hope that the patient could survive until the next donor could provide his need. By now the patient was receiving oxygen only and the anæsthetist chose the safer course and continued to administer intravenous saline. Spontaneous respiration failed half an hour later, and although manual ventilation was maintained and further blood was administered an hour later, the patient did not recover.

Discussion

To what extent were these deaths attributable to the operation, and to what extent to the anæsthetic? In the first two cases it seems probable that both operation and anæsthetic contributed to the death. In the first case it is likely that the patient suffered an unnecessary depth of anæsthesia because of the ineptitude of the anæsthetist. It is certain that his condition was not observed carefully. Had the anæsthesia been competent in these respects it is possible that he might have survived. On the other hand it is also possible that an operation of lesser magnitude and duration might have proved an adequate palliative.

The second case remains an enigma. It is inconceivable that a patient could be in good condition at 1-10 p.m. and yet be dead of asphyxia within three minutes without showing any abnormal signs. And the findings at autopsy support this contention. Since the obstruction of the lumen of the tube was only partial, we must seek elsewhere for the cause of sudden death. Unlikely though it may seem, the only hypothesis which can explain the facts is to suppose that, owing to some mechanical derangement, the endothermy suddenly provided an electrical shock to the vital centres in the medulla. It was being used in close proximity to them. If this is so, it is nevertheless true that the respiratory obstruction resulting from the partial blocking of the tube must have increased the patient's difficulties and contributed to the fatal outcome.

In cases 3, 7, and 5 the death was due to the operation. In the first two it was occasioned by hæmorrhage, and in the

third by the sudden release of pus when the pulmonary abscess burst. Case 3 would probably not have ended fatally had there been no misunderstanding with the donor. Judging by the rate at which hæmorrhage took place in case 7 it is unlikely that, even had the fourth donor been compatible, the patient could have been saved. In both cases the anæsthetist took action promptly. The inexperience of the anæsthetist was to some extent to blame for the fatal result in case 5. It is possible that the patient might have survived if endobronchial drainage by suction had been instantly available. The anæsthetist was in ignorance of this technique at the time. So rapidly did the bronchial tree fill up, however, that the patient would probably have drowned before pus could have been evacuated.

An anæsthetist is not entitled to an opinion on matters of operative technique. Those better qualified to judge must decide whether the operations could have been modified in a way which might have prevented these catastrophes.

In cases 4 and 6 the anæsthesia and not the operation was the cause of death. As far as one can judge on the evidence of others, I believe the child died of a relative hypoxia. She was suffering from peritonitis, her temperature was 102° and she therefore needed a large amount of oxygen. Although there was no respiratory obstruction, she was sufficiently deeply anæsthetised to have a marked reduction of respiratory exchange, and no additional oxygen was being given. Had she been fully oxygenated she would probably have survived.

There is an old proverb which stresses the folly of "changing horses when crossing a stream." The feelings of both anæsthetists who participated in case 4 have taught them this lesson for life. Changes in personnel in the course of an operation cannot always be avoided, but if a tragedy occurs after a change the parties concerned are usually sorry that they did not complete the case. In the case under consideration, either the anæsthetist who performed induction should have finished the anæsthesia himself, or he should have made the surgeons wait until his relief arrived.

It would be easier to speak dogmatically as to the cause of death in case 6 if one had seen the behaviour of the patient

on his return to the ward. Descriptions by the nursing staff leave room for doubt whether the "periodic" respiration was due to recurrent respiratory obstruction or to incipient medullary failure. The anæsthetist in charge was to blame for allowing a student to take too much responsibility for a patient who was known to be difficult to manage. In view of the difficulty in maintaining a free airway the endotracheal tube should probably have been left in place until consciousness had been recovered. Instead of starting the next case the anæsthetist should have remained with the patient and should have satisfied himself that anæsthesia was light and that the freedom of the patient's airway was properly safeguarded before he left the operating room. These factors were probably of greater moment than the pericardial adhesion found at autopsy. Of these seven deaths, then, three were chiefly due to the operation and two to anæsthesia. In the remaining two, both factors probably contributed to the death.

Could these deaths have been prevented? Without discussing some modification of the operation, the anæsthetist could probably have avoided death in cases 1, 4 and 6. Lighter anæsthesia and an earlier recognition of circulatory exhaustion in case 1; lighter anæsthesia and adequate oxygenation in case 4; light anæsthesia and more careful attention to the airway in case 6 might have saved these patients. It is possible that endobronchial anæsthesia or adequate endobronchial drainage might have saved the patient in case 5. This, however, is a matter of speculation.

It is interesting to note the dates of these deaths, and to observe that the fatalities grow relatively less frequent as the experience of the individual increases. This fact of itself supports the view that, in the hands of some more experienced worker, some of these patients would not have died. It is, however, encouraging to remember that, in this series of 13,000 anæsthetics, there were about thirty patients who were not expected to survive the operation. The majority died soon afterward, but at least they recovered from anæsthesia.

Fear is a poor counsellor, and the anæsthetist must learn not to be afraid. Vainglorious self-confidence, however, is a more dangerous attribute than fear. The experienced

anæsthetist follows the via media between these extremes. He faces the facts, having done his best to ascertain and evaluate them; conscious always of the dangers, but knowing what he can do to overcome them. *Humanum est errare*. From time to time we fail, and the patient dies. None of us is omniscient, and growing experience shows us with increasing clarity how little we know. Ignorance is a pardonable sin. Laziness is not. Looking back on these tragedies the only consolation is that they were due to ignorance and not to laziness. The only unforgivable sin is being too indolent to make an extra effort.

ANÆSTHESIA FOR NEUROSURGERY

WITH SPECIAL REFERENCE TO TRICHLORETHYLENE

BY

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DURING a surgical operation on the brain or spinal cord hæmorrhage not only adds greatly to the technical difficulties encountered by the surgeon, but may seriously prejudice the ultimate recovery of the patient. It is most important, therefore, that vascular congestion should be reduced to the minimum, and for this reason methods of anæsthesia which give every satisfaction in other branches of surgery may require modification before they are suitable for neurosurgical procedures.

Even with the most expert administration nitrous oxide-oxygen may in certain cases lead to vascular congestion and peripheral venous oozing. Two factors are responsible for this (1) there may be accumulation of excess CO_2 in the rebreathing-bag, and (2) the patient exhales against the resistance of the rebreathing-bag and spring-loaded expiratory valve. Admittedly the resistance may be very small, but in certain circumstances it tends to raise the intrathoracic pressure and partially obstruct the venous return to the left heart, resulting in vascular congestion and venous oozing at the site of operation. The degree in which this may be present varies according to the amount of respiratory obstruction present, the state of the patient's cardiovascular system, the nature of the operation and the efficiency or otherwise of the anæsthetic apparatus. During an abdominal operation haemorrhage may be negligible, but when vascular parts such as the breast or perineum are involved it may be so profuse as to arouse misgivings in the mind of the most bigoted gas-oxygen (or cyclopropane) enthusiast. The sur-

geon usually has no doubts about the cause of the hæmorrhage, and is apt to make sarcastic references to the "good old days" of open ether and chloroform. Even when the CO_2 absorption technique is employed increased bleeding may still be present, especially towards the end of the operation when the skin and underlying tissues are being sutured. Whether this is due to the soda-lime losing its efficiency, "straining" under light anæsthesia, or a rise in blood-pressure following closure of the abdominal cavity, one fact cannot be disputed—vascular congestion and haemorrhage are definitely less when "open" methods of anæsthetic administration are employed.

Apart from the question of venous oozing, nitrous oxide-oxygen has many disadvantages from the point of view of the neurosurgeon. Unless full doses of morphia, scopolamine, tribromethanol or other depressant drugs are previously administered, it is not possible to maintain anæsthesia without anoxæmia. On the other hand, morphia and basal narcotics depress the vital centres in the medulla to an extent which may be dangerous, especially when the intracranial pressure is already raised by injury or disease. Moreover, the prolonged postoperative sleep which often follows the use of these drugs may mask important cerebral symptoms which would otherwise be recognized in time.

During the last eight years the majority of cases in the Neurosurgical Department of the Newcastle-upon-Tyne General Hospital have been anæsthetized by the "open" T-piece technique,[1] in which the rebreathing-bag is replaced by a rubber tube open to the air at one end and connected to the intratracheal tube at the other. Through the transverse limb of a metal T-piece incorporated in the rubber tubing, nitrous oxide-oxygen supplemented by ether or other volatile anæsthetic is "injected" into the system. Theoretically it might seem impracticable to administer nitrous oxide with the circuit open to the air; but, in practice, a light plane of anæsthesia can be maintained indefinitely by adjusting the flow of nitrous oxide to 2 to 4 litres with oxygen $1\frac{1}{2}$ to 2 litres a minute, the gases being supplemented by minimal quantities of ether or chloroform. So marked is the absence of vascular congestion with the T-piece technique

that the present Surgeon in Charge of the Neurosurgical Department refuses to allow any other method, although for many years his cases were anæsthetized (in another clinic) by more orthodox methods involving the use of tribromethanol and nitrous oxide-oxygen administered by the closed or semi-closed technique.

Until a year ago ether or chloroform was used as the supplementary agent, and despite the bad reputation of the latter drug the condition of the patients both during operation and afterwards was excellent in every respect. However, it must be admitted that considerable judgment is required to administer chloroform successfully, and in the hands of an incompetent or inexperienced anæsthetist it may be anything but safe. A year or two ago Langton Hewer[2] introduced trichlorethylene as a general anæsthetic, and it seemed that here might be a non-inflammable agent suitable for use with diathermy apparatus and without the potential dangers associated with chloroform. This proved to be the case, and since July 1942 105 patients undergoing operation on the brain or spinal cord have been anæsthetized with trichlorethylene, with such good results that this agent is now used as a routine for neurosurgical cases.

Description of Technique

When preparing the patient for a neurosurgical operation it is most important that starvation and violent purgation should be avoided. If the operation has been arranged for the afternoon a light breakfast may be allowed in the morning supplemented by a cup of soup or meat extract at midday. It is wise to administer glucose in one form or another during the preceding 24 hours, especially in the case of children. If the patient cannot sleep a barbiturate or other mild hypnotic may be given in the evening before operation, but often this is unnecessary.

One hour before the time of operation the patient is given a hypodermic injection of Omnopon (pantopon) gr. 1/3 with Atropine gr. 1/100. On arriving at the anæsthetic anteroom the throat and vocal cords are sprayed with 2 per cent Decicain (Pantocain) or Nupercaine: this helps to eliminate straining or coughing—another cause of vascular conges-

tion[3]—during the early stages of the operation. In most cases anæsthesia is induced by intravenous injection of 5 per cent Pentothal Sodium, the amount varying from 4 to 10 c.c. according to the physical condition of the patient. Nitrous oxide-oxygen and trichlorethylene are administered by the orthodox semi-closed technique until the jaw is sufficiently relaxed to insert a Magill tube into the trachea; this is preferably carried out orally under direct vision laryngoscopy. Anæsthesia is continued until the patient is firmly established in the first plane of the third stage, when the rebreathing-bag is removed and replaced by the T-piece attachment. To the distal or open end of the latter is attached a length of wide-bore (internal diameter 1 cm. approx.) rubber tubing. The exact length of the rubber tubing is not important and may be varied to suit the conditions; for adults 3 to $3\frac{1}{2}$ feet will be about right, especially in neurosurgical cases where the anæsthetist has to work at a distance from the site of operation. Finally, the mouth is packed off with gauze wrung out in liquid paraffin.

During the operation the flow of gases is adjusted so that the minute volume of nitrous oxide is 2 to 4 litres with oxygen 2 litres, the gases being allowed to flow over the surface of the trichlorethylene—it is rarely necessary to "bubble through" the liquid. In the case of exceptionally resistant patients a little ether may be given for ten minutes until the patient has settled down. The average quantity of trichlorethylene required to maintain anæsthesia in the first plane varies from 2 to 4 drachms an hour, although rather more than this may be needed during the first hour while the bone flap is being trephined. After the dura has been opened and the brain exposed, the nitrous oxide is usually discontinued, the flow of oxygen being increased to 4 litres a minute, and trichlorethylene administered intermittently. With practice it is surprising how little anæsthetic is needed to maintain adequate anæsthesia, and not infrequently on removing the intratracheal tube at the end of the operation the patient will open his eyes and reply to questions. Indeed, if the patient is still deeply asleep and the superficial reflexes are absent, it is highly probable that some cerebral complication (e.g. a blood clot) has arisen.

While the operation is in progress routine observations should be taken of the blood-pressure, pulse and respiration. The latter may conveniently be observed by affixing a single strand of gauze to the distal end of the rubber tubing: this will wave to and fro with the patient's respirations. It is also wise to set up an intravenous "drip" during the early part of the operation, so that plasma or whole blood may be given without unnecessary delay.

Case Records

During a period of twelve months, commencing in July 1942, a total of 105 neurosurgical patients were anæsthetized with nitrous oxide-oxygen and air supplemented by trichlorethylene. These may be subdivided as follows:

Brain tumour	35
Brain abscess	3
Nerve root section	12
Laminectomy	25
Head injuries	15
Miscellaneous	15

These figures represent cases anæsthetized by the writer and do not include those done by other members of the anæsthetic staff, who also used trichlorethylene with equally good results. In fact one of the great advantages of the T-piece method is that once the intratracheal tube is in position the patient can be safely left with a junior house-surgeon or nurse. It is practically impossible for any harm to come to the patient; even if the oxygen supply should inadvertently run out the patient can still inhale air through the T-piece until the deficiency has been rectified.

The following are case reports and anæsthetic charts of four patients undergoing neurosurgical operations.

Case 1. A woman, aged 64, in bad physical condition (grade 3) and suffering from a tumour in the right cerebral hemisphere.

Clinical data. Blood-pressure 150/95; pulse 120. Cachetic and dehydrated.

Premedication. Atropine, gr. 1/200.

Induction. Nitrous oxide-oxygen and trichlorethylene.

Maintenance. Nitrous oxide-oxygen-air and trichlorethylene.

Technique. Oral intubation and " open " T-piece.

Local infiltration of scalp with procaine.

Operation (September 9th, 1942). Partial extirpation of large meningioma. Operation lasted three hours and twenty minutes during which one ounce and three drachms of trichlorethylene were administered. Ten minutes after the operation was ended the patient replied to questions. Blood-pressure, 125/85; pulse 135. No pallor or sweating.

Progress. Vomited more than usual, possibly owing to poor physical condition. Fairly well the next morning and was discharged from hospital one week later.

Comments. Respirations averaged 30 to 35 during operation, but otherwise anaesthesia was tranquil and free from vascular congestion. One pint of plasma was administered intravenously during operation.

Case 2. A female child, aged 6, in bad physical condition (grade 3), suffering from a tumour of the cerebellum. Under weight and poor physique. Due to raised intracranial pressure she was flushed and irritable, with a slow pulse, irregular in rate and force.

Clinical data. Blood-pressure, 95/65; pulse 50 (75 after atropine).

Premedication. Atropine, gr. 1/200.

Induction. Oxygen-nitrous oxide and trichlorethylene.

Maintenance. Oxygen-air and trichlorethylene.

Technique. Oral intubation and " open " T-piece. Local infiltration.

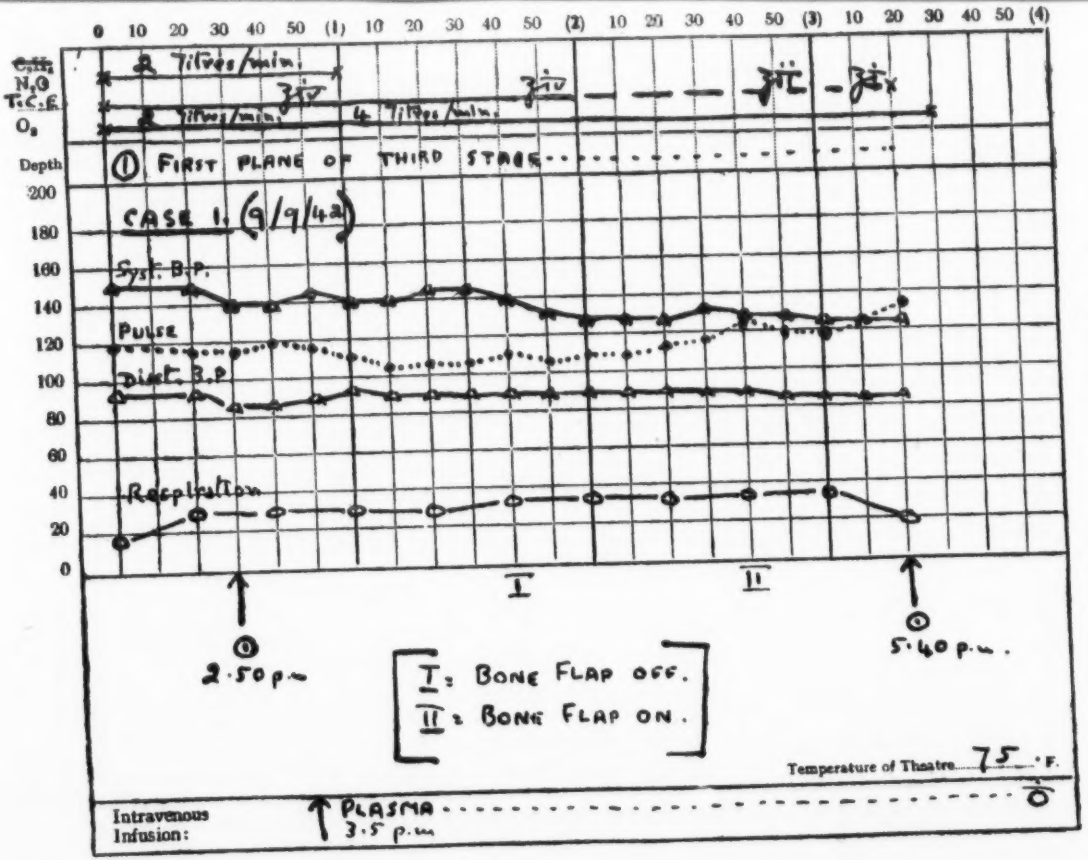
Operation (February 1st, 1943). Removal of cystic glioma in midline of cerebellum.

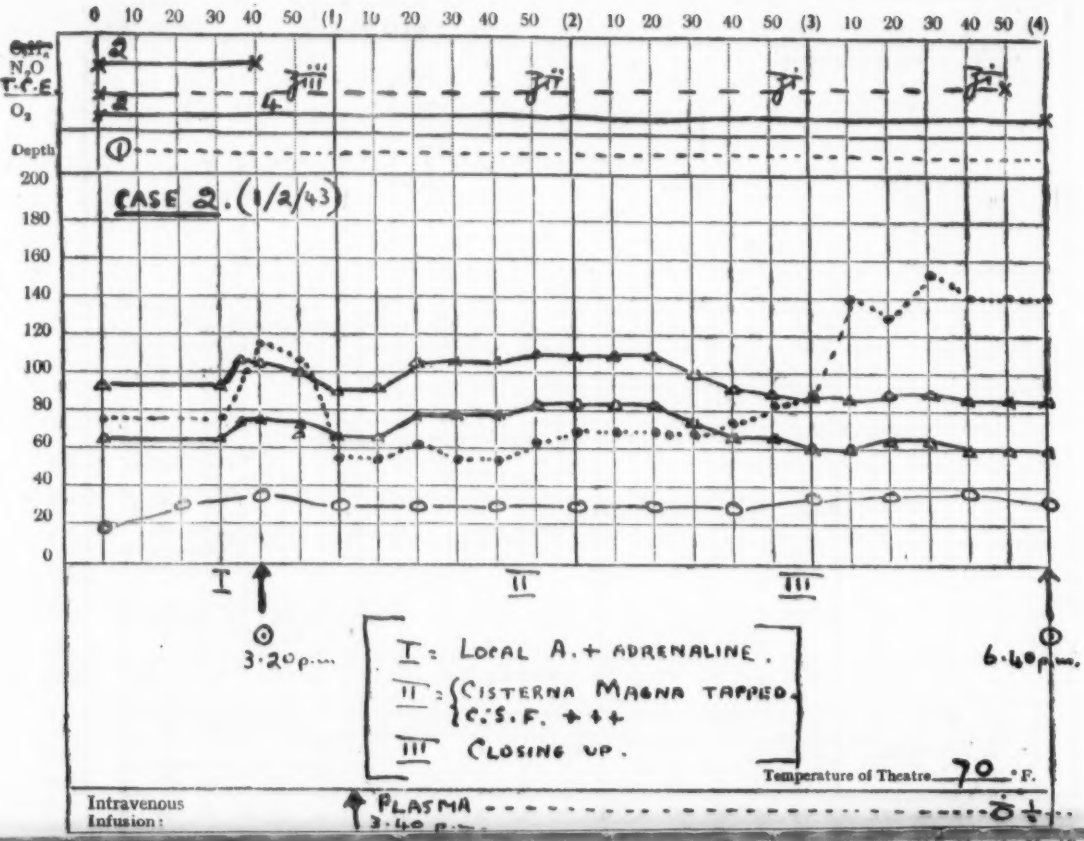
No special difficulties encountered during operation which lasted four hours. At end of operation child was moving and superficial reflexes were present. General condition very fair. Blood-pressure, 85/58; pulse-rate 140. Good colour. No sweating.

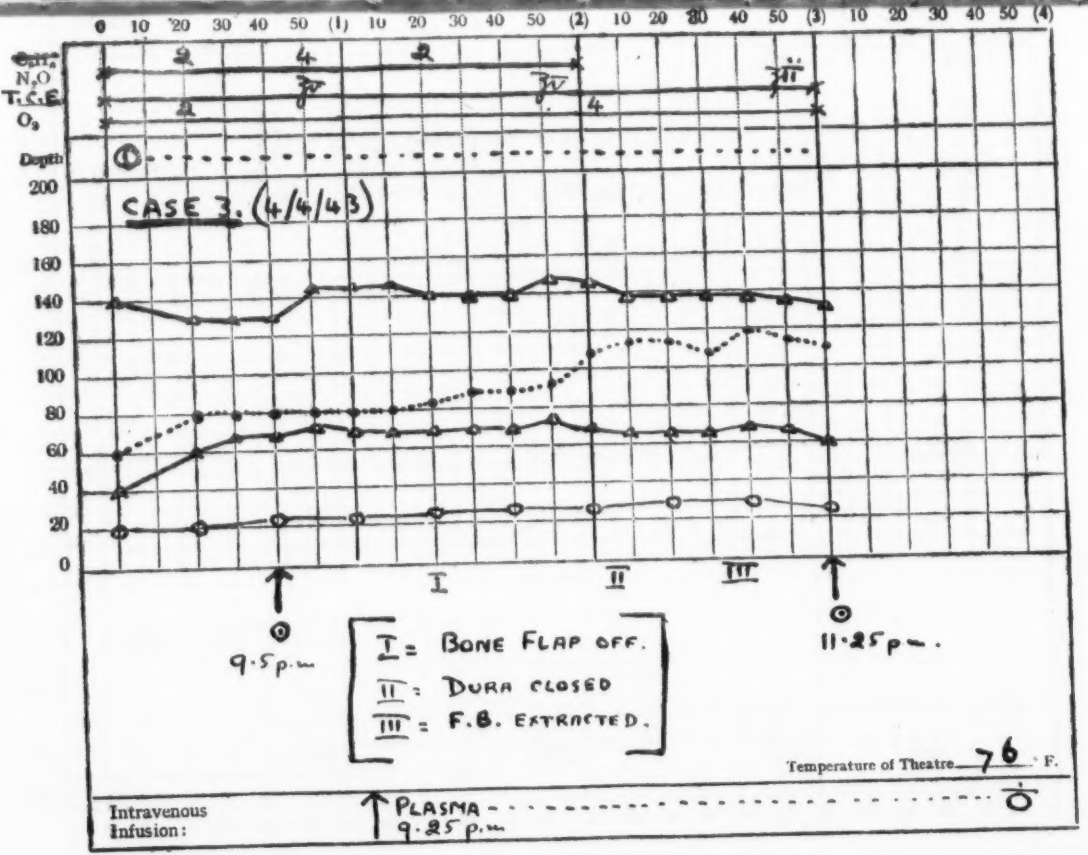
Comments. Respirations averaged 30 to 40. Any increase in trichlorethylene, which was given intermittently throughout, tended to increase rate of respiration. Pulse regular and not unduly rapid until after removal of tumour, when it rose to 140. One pint of plasma was given intravenously during operation.

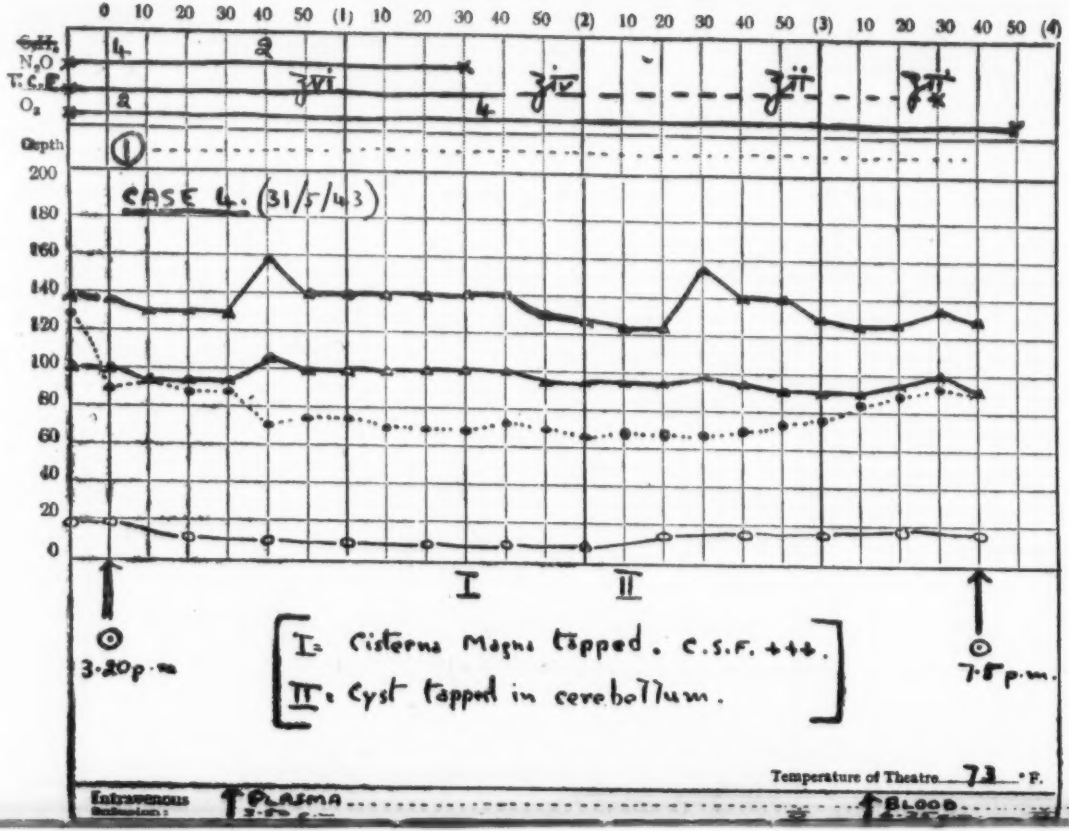
Special note. No anxiety was experienced regarding the use of trichlorethylene in this case; but ether would have been substituted if the rate of respiration had risen any further, or if the pulse had become irregular. Seven drachms of trichlorethylene were used.

Progress. No vomiting or other complication. Child was discharged from hospital about three weeks later.


0 10 20 30 40 50 (1) 10 20 30 40 50 (2) 10 20 30 40 50 (3) 10 20 30 40 50 (4)
Cyclo
N₂O
T.C.E
O₂
2 Litres/min.
3½
2 Litres/min.
4 Litres/min.
Depth
① FIRST PLANE OF THIRD STAGE
CASE 1. (9/9/42)
Syst. B.P.
PULSE
Diast. B.P.
Respiration
200
180
160
140
120
100
80
60
40
20
0
I
II
2.50 p.m.
5.40 p.m.
I: BONE FLAP OFF.
II: BONE FLAP ON.
Temperature of Theatre 75 °F.
Intravenous Infusion:
PLASMA
3.5 p.m


0 10 20 30 40 50 (1) 10 20 30 40 50 (2) 10 20 30 40 50 (3) 10 20 30 40 50 (4)
Cyclo.
N2O
T.C.E.
O2
Depth
200 180 160 140 120 100 80 60 40 20 0
CASE 2. (1/2/43)
I
II
III
3.20 p.m.
6.40 p.m.
I = LOCAL A. + ADRENALINE.
II = CISTERNA MAGNA TAPPED. C.S.F. +++
III CLOSING UP.
Temperature of Theatre 70 °F.
Intravenous Infusion:
PLASMA
3.40 p.m.


0 10 20 30 40 50 (1) 10 20 30 40 50 (2) 10 20 30 40 50 (3) 10 20 30 40 50 (4)
Cyclo.
N_2O
T.C.E.
O_2
Depth
CASE 3. (4/4/43)
200
180
160
140
120
100
80
60
40
20
0
I
II
III
9.5 p.m.
11.25 p.m.
I = BONE FLAP OFF.
II = DURA CLOSED
III = F.B. EXTRACTED.
Temperature of Theatre 76 F.
Intravenous Infusion:
PLASMA
9.25 p.m.


0 10 20 30 40 50 (1) 10 20 30 40 50 (2) 10 20 30 40 50 (3) 10 20 30 40 50 (4)
N₂O
O₂
Depth
200
180
160
140
120
100
80
60
40
20
0
CASE 4. (31/5/43)
I
II
3·20 p.m.
7·5 p.m.
I: Cisterna Magna tapped. C.S.F. +++.
II: Cyst tapped in cerebellum.
Temperature of Theatre 73 °F.
Intravenous
PLASMA
BLOOD

CASE 3. A young man, aged 17, injured by hand-grenade exploding prematurely during Home Guard exercises. When admitted to hospital he was pale, semicomatose and incontinent. It was discovered that a large portion of the bolt of a rifle had entered through the left orbit, and was firmly embedded in the brain at the base of the skull. Apart from shock due to the injury he was in good general condition. Blood-pressure, 140/40; pulse-rate 62.

Premedication. Omnopon gr. ½, with atropine gr. 1/100.

Induction. Nitrous oxide-oxygen and trichlorethylene.

Maintenance. Nitrous oxide-oxygen-air and trichlorethylene.

Technique. Oral intubation and "open" T-piece.

Operation (April 4th, 1943). Foreign body could be seen through orbit and also through hole in skull. Eventually removed with considerable force through orbital wound. Operation lasted three hours during which 1½ ounces of trichlorethylene were used. Condition of patient at close was good. Superficial reflexes present. Blood-pressure 132/60; pulse-rate 106. Good colour. No sweating.

Comments. Respirations averaged 20 to 27. Anæsthesia satisfactory. One pint of plasma given intravenously during operation.

Progress. No vomiting or other complication. Went home six weeks later apparently healed and well. Two weeks later he unfortunately developed meningitis following a cold, and was readmitted to hospital in *status epilepticus*. Died a few days later. Post-mortem revealed a defect in the inner aspect of the orbit with perforated cribiform plate on the left side. The optic nerve was severed and there was a large laceration in the left frontal lobe of the brain. The left and part of the right side of the cribiform plate were missing, and the brain was protruding through the gap.

CASE 4. A middle-aged man, 50, in fair general condition (grade 2), with three years history of headache and vomiting due to a tumour of the cerebellum.

Clinical data. Blood-pressure 140/100; pulse-rate 128 (after premedication).

Physique and weight normal. Slight chronic bronchitis.

Premedication. Omnopon gr. ½, with atropine gr. 1/100.

Induction. Pentothal sodium, six c.c. of 5 per cent solution. Nitrous

Operation (May 31st, 1943). Removal of cystic astrocytoma from oxide-oxygen and trichlorethylene.

Maintenance. Nitrous oxide-oxygen-air and trichlorethylene.

Technique. Oral intubation. "Open" T-piece. Local infiltration. left lobe of cerebellum. One and three-quarter ounces of trichlorethylene were given over a period of four hours and ten minutes. At the

end of the operation the patient was moving and groaning. Blood-pressure 130/90; pulse 90. No pallor or sweating.

Comments. Owing to the very high intracranial pressure in this case the patient was unduly depressed during induction of anæsthesia, and oral intubation was performed during a period of apnoea. Controlled respiration immediately restored normal breathing, and no further difficulty was experienced during the operation. Respirations averaged 8 to 10 during the first 2½ hours and were periodic and apneustic in character. After a cyst in the left lobe of the cerebellum had been tapped, respirations improved to 18 for the remainder of the operation. Nearly a pint of plasma and a pint of blood were given intravenously.

Special note. Possibly an error of judgment was made in giving this patient both Omnopon and Pentothal, in view of the high intracranial pressure before operation.

Progress. Patient recovered consciousness half an hour after leaving the theatre. No vomiting or chest complications. Convalescence was normal.

Effect of Trichlorethylene on Respiration

In the series of 105 neurosurgical cases under review, the maximum rate of respiration was as follows:

Rate	Number of cases
0 to 20 per minute	14
21 to 30 ,, ...	47
31 to 40 ,, ...	34
41 to 50 ,, ...	6
51 to 60 ,, ...	4

From the above figures it will be seen that in approximately 60 per cent of cases the rate of respiration was below 30, in 30 per cent it was between 30 and 40, and in 10 per cent of cases it exceeded 40 per minute. Although as yet only one explanation[4] has been offered as to why the respiratory rate should increase in this manner, no harm seems to come to the patient, nor is any inconvenience caused to the surgeon as a rule. Of the ten cases when the rate of respiration exceeded 40, two were children under six years of age, three were in poor physical condition due to toxaemia or malignant cachexia and one was an obese short-necked man of 64 suffering from chronic bronchitis and emphysema.

Cardiac Irregularities due to Trichlorethylene

Considerable discussion[5] has arisen regarding the effect of trichlorethylene on the conducting tissue and muscle of the heart. In the present series only two cases occurred in which the cardiac condition gave rise to anxiety. Both were elderly women in very bad physical condition (grade 4), and undergoing operation for brain tumour. In one case a 2 : 1 heart block (?auricular flutter) persisted until the trichlorethylene was discontinued. In the other case the pulse became very irregular shortly after induction of anæsthesia: in spite of ether being substituted for trichlorethylene the irregularity persisted for an hour and a half, when the pulse improved. Trichlorethylene was again administered cautiously, but the pulse remained regular and there was no further change during the remainder of the operation. In neither of these cases was there any alteration in respiration or blood-pressure associated with the cardiac irregularities.

Apart from these two cases minor cardiac irregularities were observed on five other occasions, bringing the number of cardiac complications up to seven or a little over 6 per cent of the total. One patient had a few extra-systoles following local infiltration of the scalp with procaine containing adrenaline—the only occasion on which adrenaline appeared to have any effect on the pulse during trichlorethylene anæsthesia.

Persistent bradycardia, as reported by Gordon and Shackleton,[6] was not present on any occasion. It should be mentioned, however, that in the present series the depth of anæsthesia never descended below the first plane of the third stage, which possibly accounts for the low incidence of cardiac irregularities observed. Unfortunately, electrocardiograph studies were not obtained.

Postoperative Complications

Owing to pressure of work and war difficulties detailed information concerning postoperative vomiting was not obtained in every case. In the majority of cases vomiting was slight or absent, and only on a very few occasions did

patients complain of nausea after operation. One patient developed a postoperative atelectasis involving the lower lobe of the left lung: owing to technical difficulties caused by kinking of the intratracheal tube, the respirations were somewhat laboured during the course of the operation, and it is probable that trichlorethylene was not to blame on this occasion. An epileptic patient with chronic bronchitis had a cough accompanied by pyrexia for a few days following operation. Apart from these two cases there were no chest complications due to trichlorethylene. Postoperative recovery was rapid, and most patients were fully conscious. within an hour from the time the operation ended.

Comments and Conclusions

Trichlorethylene provides a safe and pleasant anæsthesia for neurosurgical operations, most of which require little more than analgesia. By using the "open" T-piece technique anæsthesia is tranquil and free from vascular congestion. Possibly because air is admitted to the system and there is no accumulation of anæsthetic, cardiac irregularities are few and the rate of respiration is not unduly rapid. From reports published it is evident that most of the difficulties encountered are associated with closed methods of administration, in which the anæsthetic concentration may rise to a higher level than when an open method is employed.

Trichlorethylene should be used with caution in the case of young children or patients suffering from toxaemia or heart disease. It is especially suitable for operations where a light plane of anæsthesia is required; when deep anæsthesia is necessary, cyclopropane or ether is better from every point of view.

When the services of a skilled anæsthetist are available almost any neurosurgical operation (except closed head injuries) can be performed under general anæsthesia with benefit to all concerned. For minor procedures continuous intravenous Pentothal Sodium is very useful, providing care is taken to maintain a free airway. If the anæsthetist is prepared to support the patient's jaw for four hours, this method may also be used for major operations; but it is

doubtful whether the results are worth the trouble. In suitable cases rectal Pentothal (1 gm. per 50 lbs. body weight) forms a pleasant method of inducing anæsthesia in young children, especially for encephalograms, or "cleaning up" and suturing scalp wounds. Recently a technique has been described[7] in which rectal tribromethanol supplemented by intravenous Pentothal Sodium is the anæsthetic of choice for neurosurgical operations: this method has attractive possibilities but it is not stated whether difficulties are encountered in maintaining a free airway.

In concluding this paper I wish to acknowledge the help and encouragement which I have received from Mr. G. F. Rowbotham, Surgeon in Charge of the Neurosurgical Department at the Newcastle-upon-Tyne General Hospital.

References

1. Ayre, T. P. *Lancet*, March 6th, 1937, p. 561.
2. Hewer, C. L. *Proceedings of the Royal Society of Medicine* (Anæsthetic Section), March 6th, 1942; also "Recent Advances in Anæsthesia and Analgesia," 4th edition, chapter VII.
3. Brennan, H. J. *Lancet*, February 5th, 1938, p. 315.
4. Culbert, T. D. *Brit. Med. Journ.*, May 8th, 1943, p. 582.
5. Waters, R. M., O. S. Orth, and N. A. Gillespie. *Anesthesiology*, January 1943, Vol. IV, No. 1.
6. Gordon, R. A., and R. P. W. Shackleton. *Brit. Med. Journ.*, March 27th, 1943, p. 380.
7. Durshordwe, Clarence J. *Current Researches in Anesthesia and Analgesia*, March, 1942, Vol, 21, No. 2, p. 61.

THE NEED FOR AN ACCURATE UNDERSTANDING OF ANÆSTHETIC RISKS

BY

JOHN ELAM, B.A., M.R.C.S., L.R.C.P.

MR. HAMILTON BAILEY'S statement that he had found it necessary to perform cardiac massage on certain occasions in his surgical career did not meet with quite the reception one might have hoped for.

It was indeed suggested that the number of times he had experienced these sudden and dramatic incidents was out of all proportion to what might reasonably be expected. Yet deaths and untoward incidents under anæsthesia and during surgical operations do occur, and how treacherous a thing is human memory. Can we call to mind all the times we heard the fluttering of the angel's wings?

Those of us who are engaged in general practice owe a duty to our patients to see that they are protected from these accidents so far as is possible, and here we are greatly handicapped in that there is too great reluctance to publish bad results, and perhaps too much enthusiasm to publish good results of surgical operations. What do we mean by a good result?

The standard of test for a surgical operation is that the patient is afterwards enabled to resume a full and useful life. The thyroid patient who returns to us with both recurrent laryngeal nerves divided and a permanent paralysis of the cords, cannot be described as an unqualified success.

In the case I have in mind I do not think the accident could have been avoided; the risk was great and all knew it. But when a patient in early middle life, who has undergone an operation under spinal analgesia for a small hernia, returns home with what appears to be permanent incontinence, one is deeply distressed.

A question was recently asked in Parliament about the death of a young soldier from paralysis and toxæmia seven months after an operation for hernia under spinal analgesia, and a practitioner describing his technique of cardiac massage casually mentions that he had recently performed this desperate remedy for a patient who collapsed during an appendix operation under spinal. Yet why does one read of these disasters so seldom in the medical journals?

In my own district we have had some distressing deaths under intravenous anæsthesia. A charming young friend needed her appendix removed. Anxious that she might be spared the unpleasantness of an inhalation induction, she was given an intravenous barbiturate. She died before the injection was finished.

A young soldier in a neighbouring hospital died under exactly the same circumstances; and one of my dental surgeon friends has just lost two patients under intravenous anæsthesia, when gas would have done perfectly well in both cases.

In each of these cases the anæsthetists concerned were on the staff of a major London hospital, and each said that it was the first death he had experienced under intravenous. Reading the medical journals one cannot but be impressed with the slenderness of the evidence on which practitioners may base a claim that A or B is the anæsthetic of choice. A series of cases successfully anæsthetised with a particular drug merely makes out a case for investigation. In the correspondence following Mr. Bailey's article it was suggested that chloroform might be the cause of the troubles experienced.

But what chloroformist of thirty years ago could not point to a series of 1,000 or 2,000 cases given chloroform, without anxiety?

We have banished the old devil chloroform from our midst. Was he such a bad old devil, after all, and have we not introduced into our house other devils worse than the first?

Who can judge if practitioners will not tell us of their misfortunes?

J. L. Hansen[1] strongly urges need for publication of fatal

cases; and the BRITISH JOURNAL OF ANÆSTHESIA stresses need of reporting accidents, while Gillespie[2] notes that literature contains a wealth of opinion; but that scarcely any of these opinions are founded on the solid basis of recorded observation, while Flagg[3] notes that the volume of a single man's experience is too small to form a true statistical estimate for use by others.

Is it not possible that Mr. Hamilton Bailey has done us a great service, and is it not possible too that perhaps the newer anæsthetic techniques which have replaced chloroform are even more dangerous? Can we try to find out what is the average mortality on the table?

Clement[4] quotes Bournes' figures of 1 in 50,000 with N_2O; 1 in 16,000 ether; 1 in 400 chloroform; 2 in 6,000 spinal. Australian[5] authorities for a series of 55,000 major operations find immediate death-rate 1.8 per 1,000, and for 13,900 minor operations 0.3 per 1,000. St. Thomas's Hospital in one series found mortality as 2 per 1,000. George Edwards[6] finds there were 15 deaths in 10,000 cases at St. George's.

Jarman,[7] after an exhaustive survey of the subject, feels that "... up to the present time there is not an anæsthetic body that has ever attempted to record anæsthetic deaths in such a way that the cause may be discovered and classified."

Hewer[8] quotes a large series of 15,652 spinal administrations in 18 American hospitals with an immediate mortality (on the table) of 40, or 1 in 400, and quotes Saunders[9] as finding mortality under spinal as high as 1 in 200. The fierce light of publicity which has recently beat upon attempts to relieve pain in labour has also produced some important disclosures.

Montgomery[10] of Philadelphia was greatly impressed by the number and nature of anæsthetic deaths reported to the Maternal Welfare Committee, and on investigation found many preventable. Deaths from barbiturates headed the list, with deaths from spinal second. He considers spinal anæsthesia specially dangerous for obstetric operations and can see no reason why this method should be selected by anyone who has reviewed the literature and is familiar with the fearful mortality connected with it.

Montgomery's fear of the barbiturates is supported by

Yandell Henderson,[11] who considered that "pharmacology affords no means of rendering childbirth free from discomfort . . . except at the cost of many dead or damaged babies."

Hall[12] of Oakland reports 14 women in labour, who, while under the influence of pain-relieving drugs, vomited. Five of these died from aspiration of vomitus.

Grant-Whyte[13] considers that although the anæsthetic death-rate in South Africa has fallen, it remains disquietingly high, and Kemp[14] says that "It is a shameful reflection upon the medical profession in general that too often the administration of ether is routinely entrusted to persons totally indifferent to and incompetent in its proper useage." We cannot indeed discover or classify the causes of anæsthetic deaths as Jarman says, but even with the very scanty information available can we really claim that Hamilton Bailey is an alarmist or that he has been unduly unlucky?

Is it possible to discover how anæsthetic deaths come about and what are the safest anæsthetic agents?

These questions are most difficult to answer, but we can gather some general ideas.

Jarman,[15] after an examination of many hundred deaths, found that 80 per cent of these occurred when the administration was in charge of newly qualified house officers, 12 per cent general practitioners and 8 per cent full-time professional anæsthetists. This hardly supports the editorial in the BRITISH JOURNAL OF ANÆSTHESIA, January 1941, which states: "The fewer anæsthetics left to the general practitioner" the better.

The BRITISH JOURNAL OF ANÆSTHESIA, October 1934 editorial considers that until we can assert with confidence that not only will the patient leave the table in safety, but that also his subsequent progress to health will be uninterrupted, should we be satisfied with our drugs and our methods. Discussing the subsequent progress of patients following operation, Professor Grey Turner[16] feels that the older methods of producing anæsthesia were more uncomfortable but safer.

Now, in our anxiety to replace chloroform, we have made use of certain other drugs and methods.

These may be classified as follows:

(1) Drugs and techniques for producing spinal anæsthesia, or analgesia. (2) Intravenous anæsthesia. (3) Local anæsthesia, or analgesia. (4) Nitrous oxide anæsthesia. (5) Cyclopropane anæsthesia. (6) Ether anæsthesia and ethyl chloride. (7) Trichlorethylene and Vinesthene.

Are these drugs and the anæsthetic techniques by which they are used more safe and satisfactory than chloroform? Does their method of administration leave room for improvement?

Spinal Anæsthesia or Analgesia

There is no prospect of agreement as to the safety and suitability of spinal anæsthesia. A famous American surgeon has said that "there is no operation upon the human body that cannot be performed with greater safety and facility with spinal or conduction anæsthesia than with inhalation anæsthesia."

Babcock[17] tells us that the dangers of spinal anæsthesia remain largely with the user rather than with the drug or the technique.

Batten[18] finds spinal the anæsthetic of choice for Cæsarean operation as does Brindeau,[19] but the latter admits having experienced three deaths under this anæsthetic.

That most famous continental surgeon, Sebrecht,[20] considers spinal the anæsthetic of choice for abdominal operation, but states that "I have never tired of drawing the attention of my colleagues to the very real dangers of spinal anæsthesia and to the menas of avoiding them." Etherington Wilson,[21] while specially favourable to spinal anæsthesia, adds that "if Cæsarean sections were all done as a routine under spinal and without particular regard to danger, there is trouble waiting round the corner."

Flagg, that wise and experienced anæsthetist, who for many years has practised in the U.S.A., where the use of spinal anæsthesia is more common than in this country, sums up the situation thus in his *Art of Anæsthesia*: "Recent advances in the technique of administering ether and other general anæsthetics reduce the occasions where regional and spinal methods are positively indicated. Regional and spinal

anæsthesia has a definite and extremely valuable place in the armametarium of the anæsthetist, but its routine use in uncomplicated cases serves but to bring it into disrepute."

He finds, as have other observers, that "the most ardent advocates of local and spinal anæsthesia must acknowledge that these techniques do not in any way reduce the incidence of post-operative chest complications."

Now let us look at the other side of the picture. Co Tui[22] gives us a review of the physiology of spinal anæsthesia, and says "the spinally anæsthetised animal may be a badly handicapped animal. His respiratory system may be crippled by thoracic paralysis and his circularity system by an inability to compensate, while the paralysis of his adrenine secretions incapacitates his mobilisation of sugar as well as of fribrinogen."

Stanley,[23] quoting Hyslop, maintains that sequelæ of spinal anæsthesia cannot be regarded as absolutely preventable and that an accurate idea as to the frequency of these sequelæ does not exist.

Also Davis Haven Givens Emmett and Lindemulder, who found prolonged changes in the cord after spinal anæsthesia. Lindemulder[24] finds there is a definite toxic effect in the spinal cord and spinal nerve roots. He mentions two deaths also—muscle tenderness and pain in legs lasting several months.

David Yaker[25] found that severe headache occurred in 15 per cent of his cases, which was distressing to both surgeon and patient.

Brennan[26] mentions one death and one very narrow escape, while Van der Post[27] describes "three disturbing cases" under spinal anæsthesia—two deaths and one very narrow escape.

Virginia Apgar[28] examined a series of 1,096 cases given spinal Pontocaine, and concluded that spinal anæsthesia was not without its complications; nausea and vomiting, urinary troubles and neurological complications all being noted.

Jennings[29] and Karabin report on 500 rectal operations under spinal anæsthesia. They found that headache occurred in 153 cases—one lasting eight months—and that nausea and vomiting occurred in 34.6 per cent of cases.

Grafagnino[30] and Seyler consider epidural spinal anæsthesia satisfactory. They report on a series of 76 cases, but admit that three nearly died; one patient only being separated from the angels' hands by immersion in the Drinker respirator for many hours.

So far as my own experience goes I must confess that my enthusiasm for spinal anæsthesia was somewhat checked after I had seen three consecutive prostate patients in one hospital die under the administration of stovaine. One died on the table, one on the way back to the ward, and one some three hours after operation. Another patient, a most brilliant scientist, after undergoing a resection of the colon under spinal anæsthesia, returned home with the mind of a child. He sat on the floor and played with pieces of paper.

Intravenous Anæsthesia

Of late years the use of intravenous barbiturates has greatly increased. Opinions as to their value and safety are again sharply contradictory, yet it cannot be denied that many deaths have occurred. How few of these deaths have been reported in the technical journals?

Jarman,[31] reviewing a series of 1,300 anæsthetic deaths, found that 21 had occurred under intravenous anæsthesia; and the Council of Pharmacology and Chemistry, U.S.A., speaking in reference to barbiturates, warn us that undue enthusiasm based on limited experience results in very unpleasant happenings.

Niederland[32] considers the risks of intravenous barbiturates greatly underestimated, and quotes 15 deaths and 50 non-fatal complications.

Barnett and Greene[33] advocate restricting intravenous anæsthesia to special cases and consider the method should only be used when specially indicated.

Rex Binning[34] discusses the use of continuous penthothal for the shocked patient and feels that its widespread use for the shocked battle casualty will show an unfavourable mortality compared with that following the use of nitrous-oxygen or Cyclopropane.

The *Journal of the American Medical Association,* February 3, 1940, discusses the danger of barbiturates, and considers that the safe single dose anæsthetic has not yet been discovered.

Paul Campiche[35] makes a strong plea for the accurate rating of anæsthesia but, taking absence of fatalities as an index, finds intravenous barbiturates half as safe as ether by inhalation.

Lonhan and Guernsey[36] find intravenous Pentothal valuable for eye operations, but in a series of 346 cases experienced 54 patients who showed mental or nervous sequelæ and 20 per cent nausea and vomiting.

Carraway[37] publishes a very successful series of cases with Pentothal, but Reynolds[38] stresses the dangers and notes that prolonged anæsthesia with this drug of even the lightest degree carries with it dangers of primary cardiac failure and damage to the liver.

Chivers and Evans[39] on shock, consider that the intravenous barbiturates must be regarded with some suspicion, and A. K. Hunter[40] noted marked repiratory depression even after small doses of rectal Pentothal.

Dunphy and Alt[41] note striking fall in blood-pressure after administration of intravenous Evipan, and found slight cyanosis-respiratory depression in 15 per cent of cases investigated.

Robert L. Patterson[42] reports three deaths under intravenous.

The pamphlet on Pentothal Sodium,[43] issued by the makers, is a model of conservative good sense. They do not recommend its use for office practice and consider that the real danger lies in the deceptive simplicity and portability of apparatus. They particularly stress that every resource of the trained anæsthetist should be at hand in case difficulties arise. "Attempts to use the drug away from such resources, in the office or at the bedside, would seem at present quite unjustifiable and could only lead to premature condemnation of an agent of great value when properly used."

How many deaths could have been prevented if this warning had been heeded?

Local Anæsthesia

The introduction of cocaine as a local anæsthetic raised hopes which were not fulfilled, but thirty years later Novocaine (or Procaine) held promise of better things.

Local anæsthesia has been more extensively used on the continent than in this country but again it has been shown that local anæsthesia *per se* reduces neither post-operative mortality nor morbidity.

Chest complications are as frequent as with ether, and Hewer[44] quotes Bortone as finding that in 50,000 unselected and consecutive operations, performed under every variety of local and general anæsthesia, the immediate death-rate under local methods was more than double that under general anæsthesia. He also quotes Bazy, who, from a study of 21,000 case reports, concludes that the adoption of local anæsthesia does not in itself diminish the operative mortality. For a number of years local anæsthesia enjoyed a period of popularity in dental surgery, and during this time it was a common experience for a practitioner to be called to the dental practitioner's surgery to assist in resuscitating a patient who had collapsed after receiving a local injection.

Though local anæsthesia still holds an important place in dental surgery one cannot help noticing to what an extent dental surgeons are returning to nitrous oxide gas. Samuel Gilman[45] notes dangerous reactions to Procaine and considers that the safe dose has never been estimated, and Professor Beuther[46] stresses the importance of preventing a local anæsthetic reaching the brain, while Clement[47] holds that syncope and death are not infrequent with local anæsthesia.

J. L. Hansen[48] reports death from Procaine poisoning, and adds his plea to the already numerous applications for the accurate reporting of fatal cases, following the use of Procaine.

H. B. Shumacker[49] reports a series of alarming and fatal reactions to local anæsthesia and expresses regret that the application of the American Medical Association, that all toxic reactions be reported, had met with poor response. His researches convince him that this lack of co-operation has led to a false sense of security.

Vaughan Hudson, and recently, Organe, have reported untoward symptons in the form of convulsions, following the use of local anæsthesia in this country.

Shchukarev[50] describes pulmonary complications in 600 cases, 75 per cent of which were done under local.

It is evident that although fatal and other complications under local anæsthesia have not been extensively reported, they do occur and that the use of local anæsthetics cannot be considered as free from risk.

Nitrous Oxide

Nitrous oxide, largely because of its safety in dentistry, has come to be considered as the safest anæsthetic, yet Macintosh and Pratt tell us that alarming symptoms may arise, and in their book describe a dramatic incident that occurred at a demonstration of the use of nitrous oxide in dentistry. It is, however, in general surgery when nitrous oxide-oxygen comes to be used, either for unsuitable cases or with unsuitable apparatus, that the chief dangers arise. It is more than possible to try to do too much with nitrous oxide and oxygen, and I have experienced two very alarming incidents from this cause.

I also feel that with some machines the percentage of N_2O–O_2 shown on the flowmeters, bears no relation to the percentage which the patient is actually inhaling. Hewer tells us that during the past few years several American workers have published details of delayed fatalities after nitrous-oxide -oxygen anæsthesia. Other cases showing alarming mental and nervous sequelæ have been described.

Cyclopropane

Cyclopropane may prove to be our most valuable inhalation anæsthetic, but it has two drawbacks. It is explosive, and before an anæsthetist can obtain adequate relaxation he must be prepared to serve a long apprenticeship in its use. Up to the present there appear to be few contra-indications to the use of cyclopropane, in highly skilled hands, but Bonham[51] notes danger of cyclopropane in allergic cases.

Kellog and Phillips[52] have remarked on a curious condi-

tion, which they describe as cyclopropane shock, coming on some hours after administration. The condition is characterised by a sharp fall in blood-pressure, but they find it can be remedied by intravenous glucose.

Jones and Burford[53] report 4 cases of massive collapse of the lungs, following cyclopropane anæsthesia.

Flagg[54] gives a stern warning. "In spite of the conservatism of these investigators [Waters and others at Wisconsin] this new agent has been popularised by less conservative groups to a degree out of keeping with its safety and value. Novelties in technique may be employed by all and sundry with a controllable margin of safety. Novelties in anæsthetic agents are quite different. The supreme penalty is not infrequently paid through unforeseen administrative complications, or from explosive accident. . . . Let us look upon cyclopropane as chloroform dispensed in gaseous form, under pressure."

Vinesthene and Trichlorethylene

These have proved useful anæsthetics, but as yet insufficient work has been done with these agents. But I have noted the value of Trichlorethylene for the shocked casualty.

Two deaths have occurred under Trichlorethylene. Both of these it may be noted were not reported in the medical journals.

Ether

Ether is the oldest anæsthetic agent and still remains the safest, yet deaths do occur under this anæsthetic. Jarman,[55] in his investigation of 1,300 deaths, found that 130 occurred under ether.

From what has been written then, it will be observed that no anæsthetic is free from danger; how great that danger is no one at present can say, and no serious attempt has ever been made to find out.

Anæsthetic mortality and morbidity is much like salmon fishing, where one's results depend not only on skill and knowledge, but on fortune, and the kind of water one is fishing. If one works at hospitals adopting a policy of selective admissions, one's anxieties are likely to be few, but where one's work lies in less favoured places, that is not so.

I managed to get through the first ten years of my anæsthetic life without a death on the table, then in one week I had two deaths and one very narrow escape.

Although I attend a number of hospitals, all my deaths on the table have taken place at one County Council hospital, where I have never been able to reduce my death on the table rate below 1.5 per 1,000 cases. I think County Council hospital work is in a special class as so many desperate cases are met with.

In a short period I had to anæsthetise, among other cases: (1) Girl of 14, with liver torn nearly in half, disintegrated spleen and ruptured kidney. (2) Lady of 75 with enormous fibroid, causing obstruction and adherent to many structures inside the abdomen, including the bladder. (3) A young woman who had been shot in the abdomen, receiving truly fearful injuries. (4) Two cases of decompression. (5) Several cases of intestinal obstruction in elderly and ill patients. (6) Two patients truly desperately ill with empyemata. All these patients recovered.

In this period I had one death, a boy of 14, who died immediately after receiving 1/3 of one gramme of Evipan. But we have not yet discovered what we set out to do. How do anæsthetic deaths come about and what are the safest agents?

In *Practical Anæsthesia*, by the Anæsthetic staff of The Alfred Hospital, Melbourne, the authors say: "The exact percentage death-rate under the various anæsthetics is variously stated by different authors. . . . These figures can have no serious meaning, since they take no account of the condition of the patient, the circumstances of the administration, the nature of the operation and the skill of the anæsthetist.

"The sole rational method of comparison would be to classify a large number of patients into A, B, C, and D class risks, to select an equal number of patients in each class, in whom the same type of operation is to be attempted, and to anæsthetise these with the particular agent under consideration. Repeating the experiment with the various anæsthetics, a true comparison of anæsthetic risk would be made possible. This has never been done."

Concluding, the authors consider:

(1) Every general anæsthesia carries a certain risk, perhaps of the order of 1.3 per thousand. It should never, therefore, be undertaken lightly, nor where regional or local anæsthesia would serve as well.

(2) The local anæsthetics have also a mortality, cocaine being the worst offender, though percaine has recently come under grave suspicion.

Low spinal anæsthesia seems to be reasonably safe, whilst high spinal anæsthesia is probably more dangerous than gas anæsthesia.

(3) Careful pre-operative examination of the patient is essential, with assessment of the anæsthetic risk and due attempts at raising pre-operatively a lowered anæsthetic tolerance.

(4) Care is necessary in the selection of the safest anæsthetic agent and technique compatible with requirements. Error, if any, should lie on the side of safety rather than of convenience.

(5) The induction stage should never be hurried nor a more toxic agent employed (especially in patients of low tolerance), for the sake of speed or convenience. Impatience of the surgeon at a slow, deliberate induction must be disregarded.

(6) The patient's stomach must be empty; where it is not, as in emergency surgery, endotracheal anæsthesia is indicated.

(7) Patency of the airways is all-important. An impaired airway increases the risk of all forms of anæsthesia, and contra-indicates ethyl chloride and chloroform, however convenient they may appear to be.

(8) Mechanical anæsthetic apparatus must be tested personally by the anæsthetist before use, and not left to the care of an attendant.

(9) The continuous recording of pulse, respiration and blood-pressure is desirable throughout all administrations. This may well apply to major procedures under regional anæsthesia, and particularly to spinal anæsthesia. The anæsthetist should not hesitate to interrupt the operation and adopt appropriate remedies should the patient enter into a state of shock.

(10) The anæsthetist must possess skill and facilities for dealing promptly and efficiently with the accidents of anæsthesia.

(11) The recovery stage requires careful supervision by the anæsthetist in person, or by a reliable and responsible deputy.

(12) Should a fatality occur, it should be discussed with entire frankness by the anæsthetist and all parties concerned, so that possible errors in judgment and technique may be detected and avoided.

I think, then, that we all might do well to take the advice of these authors and discuss with entire frankness not only those patients who die on the table, but also all untoward incidents occurring during operation.

Finally, we must always be prepared, as Mr. Hamilton Bailey suggests, to deal with the sudden emergency in the operating theatre.

References

1. Hansen, J. L. *Uges-hrift for Laeger*, February 6, 1941, 103.
2. Gillespie. *Endotracheal Anæsthesia*, 1942.
3. Flagg. *The Art of Anæsthesia.*
4. Clement. *Current Researches*, June 1933.
5. Australian Authorities. Anæsthetic Staff of Melbourne Hospital.
6. Edwards, G. *Brit. Journ. Anæs.*, April 1938.
7. Jarman. *Brit. Journ. Anæs.*, April 1939.
8. Hewer. *Recent Advances*, 1937.
9. Saunders. *Ann. of Surg.*, November 1931.
10. Montgomery. *Journ. Amer. Med. Assoc.*, May 1937.
11. Henderson Y. *Amer. Journ. Obstet.*, 1939, xxxvii, 3, 521.
12. Hall of Oakland. *Amer. Med. Journ.*, March 1940.
13. Grant-Whyte. *Brit. Journ. Anæs.*, January 1937.
14. Kemp. *Brit. Journ. Anæs.*, April 1935.
15. Jarman. *Brit. Journ. Anæs.*, April 1939.
16. Professor Grey Turner. *Brit. Journ. Anæs.*, April 1936.
17. Stanley. *Can. Med. Assoc. Journ.*, 1942, xlvi, 164.
18. Batten. *Curr. Res.*, March–April 1941.
19. Brindeau. *Paris Medicale*, 1937, xxv, 499.
20. Sebrecht. *Brit. Journ. Anæs.*, October 1934.
21. Etherington Wilson. *Brit. Journ. Anæs.*, July 1938.
22. Co Tui. *Curr. Res.*, July–August 1938.

23. Stanley. *Can. Med. Assoc. Journ.*, 1942, xlvi, 164.
24. Lindemulder. *Journ. Amer. Med. Assoc.*, July 16, 1940.
25. Yaker, D. *Curr. Res.*, July–August 1941.
26. Brennan. *Brit. Journ. Anæs.*, July 1938.
27. Van der Post. *Brit. Journ. Anæs.*, April 1938.
28. Apgar, V. *Curr. Res.*, September–October 1939.
29. Jennings and Karabin. *Amer. Journ. Surg.*, November 1939, xlvi, 317.
30. Grafagnino and Seyler. *Curr. Res.*, January–February 1939.
31. Jarman. *Brit. Journ. Anæs.*, April 1939.
32. Niederland. *Narkose Anæs.*, October 1936.
33. Barnett and Greene. *Curr. Res.*, January 1942.
34. Binning, R. *Brit. Med. Journ.*, December 7, 1940.
35. Campiche, P. *Curr. Res.*, March–April 1940.
36. Lonhan and Guernsey. *Curr. Res.*, September–October 1942.
37. Carraway. *Curr. Res.*, September–October, 1939.
38. Reynolds. *Curr. Res.*, September–October 1939.
39. Chivers and Evans. *Brit. Journ. Anæs.*, January 1941.
40. Hunter, A. K. *Brit. Journ. Anæs.*, July 1941.
41. Dunphy and Alt. *Surg. U.S.A.*, February 1937.
42. Patterson, R. L. *Curr. Res.*, 1941.
43. " Pentothal Sodium." Abbott Laboratories.
44. Hewer. *Recent Advances.*
45. Gilman, S. *New England Med. Journ.*, November 1938.
46. Professor Beutner. *Curr. Res.*, May–June 1940.
47. Clement. *Curr. Res.*, May–June 1933.
48. Hansen, J. L. *Uges-krift for Laeger*, February 6, 1941
49. Shumacker, H. B. *Curr. Res.*, July 1942.
50. Shchukarev. *Ventrik Khirugii*, May 1940.
51. Bonham. *Curr. Res.*, October 1939
52. Kellog and Phillips. *Curr. Res.*, September–October 1942.
53. Jones and Burford. *Journ. Amer. Med. Assoc.*, April 1938.
54. Flagg. *Art of Anæsthesia.*
55. Jarman. *Brit. Journ. Anæs.*, April 1939.

ASSOCIATION OF ANÆSTHETISTS OF GREAT BRITAIN AND IRELAND

ON October 28th the following officers were elected for the ensuing year:

President: Brigadier Ashley Daly.
Vice-President: Dr. C. Langton Hewer.
Treasurer: Dr. Z. Mennell.
Secretary: Dr. A. D. Marston.

The Association, at its General Meeting, sanctioned a widening of the qualifications for membership, in consequence of which it has become more fully representative of all practitioners whose chief professional interest is in anæsthetics. Hitherto the Association had confined its membership to those who were *bona fide* specialists in anæsthesia. These have now become Fellows, while the membership is open to a larger group of those interested in and practising anæsthesia.

ERRATUM

In our issue for July 1942 (Vol. XVII, No. 2) the name "Major H. K. Ashwood" should have been printed Lieut.-Col. H. K. Ashworth, to whom we offer our apologies.

ABSTRACTS

"Anæsthesia for the Badly Wounded." R. BLAIR GOULD in *Medical Press and Circular*, September 8th, 1943, p. 15.

The author first discusses shock and asserts that owing to compensatory mechanism a normal pulse and blood-pressure may be compatible with severe injury, much loss of blood and a high degree of shock. This occurs most often in young subjects. "To rush such patients into the operating theatre without preliminary treatment is to invite disaster . . . a period of observation is essential during which serial blood-pressure readings are taken and treatment initiated." He then discusses nitrous oxide, ether and pentothal, and, on the whole, most favours ether if properly vaporised before reaching the patient. Pentothal he gives very slowly, about 1 c.c. every five counted slowly, 4 in 2½ per cent solution. A nasal airway is provided through a short length of drainage tube reaching just below the base of the tongue. The needle is left in the vein. The method is not recommended for intra-abdominal operations because the dose required for relaxation is too near the toxic dose.

"Amputation under Ice Anæsthesia." A. E. MOORE and D. W. GUTHRIE in *New Zealand Medical Journal*, June 1943, p. 97.

Experimentally Allen, in 1937, found that reduction of temperature greatly reduced the danger of ligation of the main artery of a limb. Since then members of the staff of the New York City Hospital have published good results in a series of 57 major amputations carried out under ice anæsthesia. The limb is not actually frozen; it is chilled to about 2°C. at which temperature metabolism practically ceases; but although there is complete anæsthesia of proto-

plasm there is no actual coagulation such as in frostbite. This cessation of metabolism means that there is no formation of toxins to be liberated into the body with resultant shock. A further advantage of the technique is the ready healing in arteriosclerotic gangrene. Bacterial growth at the low temperature is much inhibited. Using this method there need be no upset in the general regime of a diabetic's life.

Three hours before operation ice bags are packed around the site at which the tourniquet is to be applied. This cold is felt by but not distressing to the patient. The bags are left in position for ten minutes. The limb is then raised for half a minute and a rubber tourniquet applied in the usual way. The limb is then placed in a ground sheet and completely packed in cracked ice for two hours. The patient often complains of some numbness and discomfort during the first few minutes, but this is never severe and no patient has complained of pain. The skin is then dried rapidly and prepared in the ordinary way, the operation performed; the main vessels are tied before the tourniquet is removed. In most cases the wound can be closed without drainage. When the patient is back in bed the stump is surrounded by ice bags for 48 hours. Details of cases are given.

"Delayed Recovery from Trilene Anæsthesia." S. F. Durrans, *Lancet*, August 14th, 1943, p. 191.

The writer points out that trilene, being less volatile and more highly soluble in lipoids, is much more slowly recovered from than are other anæsthetics, if the patient is saturated with the drug. He quotes cases to prove this, in which the patients did not recover consciousness for as much as 62 hours in one instance, fifteen hours in another and thirty-six in a third.

Durrans concludes that saturation of the patient with trilene should not be permitted whether by a short administration strong enough to produce abdominal relaxation or by a longer administration in the first place, nor is its use desirable for operations on any part of the respiratory tract, unless they are very short.

" Nerve Block Anæsthesia in Circumcision." B. M. ARNOLD in *S. A. Med. Journ.*, July 24th, 1943, p. 222.

The author describes a process which has been used with complete success on adults. Half an hour before injection the patient is given morphine gr. ¼, hyoscine gr. 1/150. On the table his eyes are lightly bandaged, penis and pubic area are painted with flavine in spirit; this is painless if the patient is shaved the day before. The penis is grasped with the left hand in a gauze swab from the ventral side, leaving the dorsum free. It is then pulled taut downwards, with the right hand the symphysis is felt just above the base of the penis and a fine, short hypodermic needle inserted in midline of penis an inch from pubis. Twenty c.c. of 2 per cent Novocaine containing 2 mm. liq. adrenalin 1 in 1,000 are injected raising an intradermal wheal. A 10 c.c. syringe is now substituted bearing a 2-inch needle. This is passed upwards towards the pubis at an angle of twenty degrees to the penis. At ½ to 1 inch depth it will be felt to pierce fibrous resistance and then after preliminary aspiration 10 c.c. are injected. The remaining fluid is injected a little nearer the pubis. There should be little resistance to the flow of fluid from the needle. The injected area is then massaged for a few seconds. In two minutes anæsthesia is complete.

" Convulsions during General Anæsthesia." B. S. RAY and V. F. MARSHALL in *Annals of Surgery*, July 1943, p. 130.

The authors give an account of twelve instances of convulsion during anæsthesia observed in the New York Hospital. Their article is of value because the cases are described very fully and investigation of every kind was carried out on the patients. Although it cannot be claimed that the facts brought together in these accounts did as much in anticipating convulsion at any rate they justify the authors' conclusion that anoxia is the chief factor in precipitating convulsion. " Most of the alleged causes of convulsion are not of a nature to be alone or directly responsible. But most of them bear some relationship to the delivery, transportation and utilisation of oxygen for tissue respiration, thus suggesting

anoxia as the chief factor in precipitating convulsion." They found the mortality rate to be 25 per cent and that convulsions occurred in about one in 6,000 patients subjected to general anæsthesia. They give details of the treatment they recomend and pay particular attention to the patients' position on the table, which was abnormal in several of their patients.

"*Confinement to Bed for only twenty-four hours after Operation.*" D. J. LEITHANSER in *Archives of Surgery*, August 1943, p. 203.

Although not strictly the anæsthetist's affair the contents of this article are worthy of his perusal because they bear so directly upon post-operative pulmonary complications for which the anæsthetist is often held responsible. The literature of the subject of early rising after operation is reviewed in detail. Then the details are given of a series of 464 consecutive operations, 274 appendisectomies and 190 other major surgical procedures. The average period of confinement to bed after removal of the appendix was one day, and the average period of post-operative stay in hospital for patients with acute or chronic appendicitis was 2.5 days. Patients with ruptured appendix remained in hospital for an average of 9.4 days. After other major surgical procedures the average stay in bed was one day. The patients are helped to a sitting position the day after operation, and then stand on a stool and are urged to cough. " In the presence of moist lungs the respiratory exercises were repeated several times during the day." The author claims that " reflexes from the incision and the traumatised area have a distinct relationship to the development of many of the complications that follow operation, and that early rising and special respiratory exercises lessen the reaction from these reflexes." Spinal analgesia was used throughout the series.

REVIEW

"Minor Surgery." (The Practitioner Handbooks). Edited by SIR HUMPHRY ROLLESTON, ALAN MONCRIEFF and SIR A. WEBB JOHNSON. Eyre and Spottiswoode, Ltd., London, pp. 174. Price 16*s*.

The chapter on anæsthesia and analgesia in this useful little book is by Langton Hewer. He starts with the very necessary observation that anæsthesia for minor surgery is not of minor importance. Then follow short, concise but efficient instructions for the use by general practitioners of general analgesia, inhalation and intravenous anæsthesia and local analgesia. For general analgesia the author recommends trichlorethylene and gives a description which should enable this useful procedure to be efficiently employed even by one who has had little previous experience of it. The whole chapter is a fitting conclusion to a most useful little volume.